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ARIZONA CORPORATION COMMISSION

August 2, 2019

RE: IN THE MATTER OF THE COMMISSION'S INQUIRY OF ARIZONA PUBLIC SERVICE BATTERY INCIDENT AT THE MCMICKEN ENERGY STORAGE FACILITY PURSUANT TO ARIZONA ADMINISTRATIVE CODE R14-2-101. (DOCKET NO. E-01345A-19-0076)

Dear Commissioners, Staff, and Interested Parties:

After reviewing the reports and pertinent Material Safety Data Sheets (MSDS) about the 2019 battery fire at the APS McMicken Energy Storage Facility in Surprise and the 2012 battery fire at the APS Elden Substation facility in Flagstaff, what has become apparent is that utility scale lithium ion batteries using the chemistries in those types of lithium ion batteries are not prudent and create unacceptable risks, particularly those with chemistries that include compounds that can release hydrogen fluoride in the event of a fire and/or explosion. Other utility scale battery technologies or those with chemistries that do not have an associated risk of a release of hydrogen fluoride should be utilized.

In the matter of the November 26, 2012 APS Elden Substation (Flagstaff) facility fire, the Root Cause Analysis also identifies a near miss in May 2012 when a battery cell was severely discharged and the cell was continuously charged against the intended design of the Lithium Ion Battery Energy Storage System. There were no changes to the facility's control logic to address the issues nor was an evaluation performed by Electrovaya, the designer and installer of the system. The event was not communicated to APS staff.

Also, the investigation determined inadequate electrical circuit protection and issues with the design of the temperature sensors within the modules.

There was also a June 2012 event that started when the HVAC cooling system tripped and caused multiple cells to overheat.

Two severely discharged cells in less than a year is considered a high rate of failure. But according to the Material Safety Data Sheet (MSDS) for that lithium ion battery at the Elden Substation, failed cells are "anticipated," and there were supposed to be safeguards built in to prevent an incident such as the fire.

The report highlights a serious concern with these types of lithium ion battery systems:

> "Charging a severely discharged cell (to a voltage below 2.7V) can result in internal cell breakdown and damage to the neighboring cell (thermally)."

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> "The testing of a healthy cell to a lowered voltage well below its recommended range resulted in irreversible damage to the cell internals. The separator film (20 micrometer thick) was compromised at many locations, and in a couple locations it had undergone through-wall penetration. In addition, the thermal degradation resulted in out gassing and created internal pressure that resulted in hair line separation of the molding case at its edges. This will allow the release of hot gases to the outside atmosphere this in turn potentially affecting the neighboring cell."

These gases can include hydrogen fluoride/hydrofluoric acid, which the lithium hexafluorophosphate can decompose into during a fire. Hydrogen fluoride is extremely poisonous.

The November 26, 2012 APS Elden Substation (Flagstaff) facility fire Root Cause Analysis report also warns of the dangers of a thermal runaway aided by electrical faults.

The MSDS for the battery involved in the November 26, 2012 APS Elden Substation facility fire notes that water should not be used to suppress a fire at such a battery facility, yet that was the original fire suppression used in the November 26, 2012 event. Instead of using water, there are fire suppression systems that use chemicals to suffocate the fire. This strategy would not seem at all viable for a very large facility incident, however. The Flagstaff Fire Department Report for the 2012 APS Elden Substation facility fire incident underscores the special hazards involved with the type lithium ion batteries used at that facility. It references fires with 10-15' flame lengths that grew into "flame lengths of 50-75'," with the fire "appearing to be fed by flammable liquids coming from the cabinets." The Flagstaff Fire Department Report for the 2012 incident also states concerns about "a serious risk of a large-scale explosion" and "the cabinets involved are full of lithium batteries that are extremely volatile if they come into contact with water."

Knowing now how easily a fire and/or explosion can evidently occur at these types of relatively small (2 MW) lithium ion battery facilities, it appears that a similar fire event at a very large lithium ion battery facility (250 MW+) would have very severe and potentially catastrophic consequences, and that responders would have a very difficult time trying to handle such an incident.

To appropriately plan for such a catastrophic event, the large-scale lithium ion battery facility using the same chemistries as the APS Elden Substation (Flagstaff) facility fire and the McMicken facility would need to be built in isolation far from everything else, because an explosion could potentially level buildings at some distance from the battery facility site. The energy stored at a 2 MW battery facility is equivalent to 1.72 tons of TNT. The energy stored at a 250 MW battery facility is equivalent to 215 tons of TNT. Also, large amounts of hydrogen fluoride could be released and dispersed that would affect and harm the public at a substantial distance downwind. There would be concerns also about lingering hydrogen fluoride contamination in the affected areas.

Those responding to such an incident would have to wear fire-retardant and non-conducted impermeable full body coveralls with hood, nitrile gloves, impermeable boots, and full-face tight-fitting air purifying respirators equipped with combination cartridges for acid gas and particulates.

If such an incident were to occur during the months of extremely hot and humid weather in Arizona, there would be additional challenges and burdens put upon responders.

All of this points to unacceptable hazards and risks presented by the current utility scale lithium ion battery systems using chemistries that could release hydrogen fluoride in the event of a fire or explosion. The July 8/15, 2019 edition of Engineering News-Record, in an article titled, "Fire at Arizona Energy Storage Battery Bank Draws Scrutiny," George W. Crabtree, director of Argonne National Laboratory's Joint Center for Energy Storage Research states, "If you get the temperature of the Li-ion battery above 150 degrees Centrigrade, a reaction takes place between the cathode and the electrolyte that doesn't require any oxygen from the air to proceed, and that reaction releases heat. The heat that's released heats up the battery further, and that makes the reaction go faster, and it's what they call a 'thermal runaway'. That has been the major problem with Li-ion batteries. It's very well known."

The article goes on to mention safer technologies such as a liquid flow battery that are easy to scale up linearly in terms of capacity.

There are other utility scale battery technologies that are available that are far more sustainable and do not have these risks. There are also other lithium ion batteries that utilize chemistries that do not carry the same risks as those involved in the Eldon Substation and McMicken incidents.

For example, MIT Professor Sadoway has published results of his new battery technology, using liquid metal. The battery, based on electrodes made of sodium and nickel chloride and using a new type of metal mesh membrane, could be used for grid-scale installations to make intermittent power sources such as wind and solar capable of delivering reliable baseload electricity. This type of battery has advantages that include cheap, abundant raw materials, very safe operational characteristics, and an ability to go through many charge-discharge cycles without degradation.

Zinc Air Batteries are a low-cost solution. Regenerative zinc air flow batteries efficiently store energy in the form of zinc particles and contain none of the traditional high-cost battery commodities found in lithium, vanadium, or cobalt. Conventional batteries have a fixed energy/power ratio, but zinc air batteries use a fuel tank system with flexible energy/power ratios and scalability. The storage capacity is directly tied to the size of the fuel tank and the quantity of recharged zinc fuel, making scalability a major advantage of the flow battery system. Additionally, the ability to charge and discharge simultaneously, and at different maximum charge or discharge rates, are advantages of zinc air flow batteries. Other types of standard and flow batteries like lithium-ion are limited to a maximum charge and discharge by the total number of cells, as there is no separation of the charge and discharge components.

The Nickel-Iron battery is another option and it resembles a lead-acid wet cell battery. They have three attractive properties:

1- They are almost immortal - they can last hundreds of years if they are maintained properly. Batteries that Edison built and installed in his early electric cars still work fine after refurbishing.

2- They are as environmentally benign as any battery ever created - the principle liquid electrolyte is not an acid, it is an alkaline, potassium hydroxide.

3- Ni-Fe batteries can be completely discharged, or, highly overcharged and not be damaged.

Magnesium batteries are also another option. Compared to conventional lithium-ion batteries, a magnesium battery has many advantages: When using magnesium as an anode material, energy density is increased and safety is enhanced. Magnesium is not toxic and is a very abundant mineral that is readily available. Compared to lithium, magnesium availability on earth is higher by a factor of 3000.

There are also energy storage technologies that do not utilize batteries at all.

There is a rapid technological change underway in how electric power is generated and provided to customers, especially as energy storage comes into its own. As large-scale investments are made, it would be prudent and advisable to invest in utility scale energy storage systems that are sustainable, less risky, and do not utilize chemistries that have a potential to release hydrogen fluoride in the event of a fire or explosion. Fortunately, there are many options that would work.

Please respond with your future plans regarding the use of Lithium Ion Batteries.

Sincerely,

Sandra D. Kennedy
Commissioner

On this 2nd day of August, 2019, the foregoing document was filed with Docket Control as a Correspondence from Commissioner, and copies of the foregoing were mailed on behalf of Sandra D. Kennedy, Commissioner – A.C.C. to the following who have not consented to email service. On this date or as soon as possible thereafter, the Commission's eDocket program will automatically email a link to the foregoing to the following who have consented to email service.

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